TEMPERATURE AND HUMIDITY OF THE UPPER AIR AT SAN DIEGO, CALIF.

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Abstracted by L. T. Samuels

For the past three years the Naval Aerological Observatory at San Diego has been making free-air observations of temperature and humidity by means of airplanes. These observations were inaugurated primarily in order to determine densities aloft in connection with fleet target practice. It was soon decided, however, to continue the flights both for additional information with regard to the upper air and also to determine their value, if any, in relation to weather forecasting.

The instrument (aerograph) is suspended between the wings of a plane and a graphical record obtained of temperature, humidity, and pressure. In addition, notes are made upon general weather conditions as observed from the air, cloud altitudes, visibility, etc. Wind directions and velocities are determined from simultaneous pilot balloon observations. The average altitude reached has been between 6,000 and 8,000 feet. The following excerpts are quoted from Lieutenant Wyatt's paper:

Perhaps the outstanding feature of the records obtained, other than their apparent value in forecasting, is the great inversions of temperature found to exist on practically every day of the summer season and on numerous occasions during the so-called winter season. During the months of June, July, August, and September, 1924, every flight made, except one in the month of August, showed an inversion of temperature, the magnitude of the inversion varying between approximately 10° and 20° F. The inversions were usually found to begin at an altitude between 1,200 and 2,500 feet above the surface and to extend through a layer approximately 2,000 to 3,000 feet through. Practically every flight made during those months showed an increase in relative humidity from the surface up to the start of the inversion of temperature, after which it fell rapidly. At no time did the inversion extend above 6,000 feet, and temperature had usually started to fall before 5,000 feet had been attained. Pressure distribution during these months showed continuous low or relatively low pressure over the Colorado Basin, no map showing a pressure greater than 29.90 inches. Temperatures reported from this region of low pressure were above 100° F. Winds aloft over San Diego during the times of these flights invariably showed a layer of winds with an easterly component a few hundred meters above the surface, or else very light winds to calm.

It has been noted that very frequently the upper limit of haze or fog or cloud marks the start of the inversion, visibility usually being considerably improved through and above the inversion of temperature. Practically every flight that shows an inversion of temperature and an increase in humidity with a decrease above, was made at a time when the southwest semipermanent area of low pressure was well developed.

Other flights made show no inversion of temperature and a low relative humidity at the surface decreasing from the surface upward. It has been found that when these conditions are present, the pressure distribution shows that the weather is under the control of high pressure over the Southwestern States, and from the facts in the case this is what one would naturally suppose from the theory that the atmosphere in a high-pressure area is descending.[1] In the record of the flight for November 28, 1924, no inversion was encountered, both temperature and relative humidity decreasing from the surface to the limit of the flight. Pressure distribution on that date shows a HIGH centered over northern Nevada and southern Idaho, Boise reporting a barometer reading of 30.60 inches, and a relatively steep pressure gradient existing to the northeast of San Diego. The records showing these characteristics also fall into a definite class of pressure distribution.

In another class are those records that show no inversion of temperature and either high relative humidity within the limits of the flight or an increase of humidity up to certain limits, and it is these records that have been of value in the forecasting of precipitation. The flight made on October 6, 1924, was the first flight made that showed these characteristics very definitely and precipitation occurred on the night of that date. The record of this flight shows that the sky was practically overcast with stratocumulus clouds at an elevation of 5,000 feet. Temperature fell during the entire climb except when emerging through the cloud bank where a slight inversion occurred after which temperature continued to fall. Relative humidity increased from the surface upward except when passing through inversion of temperature. Pressure distribution on the morning of this date showed high pressure over the entire country east of the Rocky Mountains and a low pressure area centered at Tonopah, Nev., that station reporting a barometer reading of somewhat lower than 29.70 inches. During the night, the low-pressure area had moved somewhat to the southeastward and was centered at Flagstaff, Ariz., and the following morning relatively high pressure showed along the entire Pacific Coast.

The flight for December 17, 1924, shows no inversion and an increase in relative humidity with altitude and shortly thereafter precipitation occurred. Of 24 records showing these characteristics, 18 were followed by precipitation, usually occurring during the night following the flight.

Although there has been insufficient data collected upon which to form any definite conclusions, there seems to be no doubt of the value of the flights in regard to forecasting and it is hoped that with the additional collecting of data, many facts hitherto unknown will be made apparent and that knowledge of them will increase the percentage of verification of forecasting in this locality, particularly in regard to precipitation. Often when there has been a doubt as to whether to issue a rain or fair weather forecast, the writer has waited until after the aerographic flight was made and if the the record showed these characteristics, a rain forecast was issued and in only one case where the forecast was based upon the aerographic flight record was the forecast of precipitation a failure. During the month of February, 1924, when precipitation occurred on three successive nights with clearing weather during the day, the forecast of rain was issued solely upon the indications of the flight record and was verified 100 per cent for the storm.

[1] The latter half of this sentence was evidently written under misapprehension as to (1) the present view of the theory that the air in anticyclones is descending, and (2) the effect of a descent of air on its relative humidity.

(1) The idea is no longer held that there is an active descent of air in anticyclones except very locally along the fringes of the mass of cold air at the earth's surface, and even here the descent is through a small vertical extent. The great body of air settles with extreme slowness. Sir Napier Shaw has calculated the rate to be about 86 meters per day for the North Atlantic anticyclone, and for small anticyclones, 3 to 5 times as much. Hence as regards relative humidity changes, these must be controlled by factors other than adiabatic heating induced by descent.

(2) If anticyclonic air did actively descend, its relative humidity would decrease from top to bottom, not from bottom to top, obviously because adiabatic warming increases the capacity of air for water vapor.—B. M. V.

DEVELOPMENT AND PRESENT STATUS OF FROST-FIGHTING DEVICES

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Nearly nineteen hundred years ago the Romans were attempting to protect their vineyards from damage by frost by building smudge fires. This method is still in use in some parts of the United States, although careful experiments have demonstrated that a smoke cover alone affords little protection.

Apparently the first actual "orchard heating," as distinguished from "smudging," on the Pacific coast was carried on in orange groves near Riverside, Calif. during the years 1897–1899. Coal baskets made of large mesh heavy wire screen were set in the orchards at the rate of 40 baskets to the acre. Good results were obtained.

The use of oil-burning orchard heaters on a large scale appears to have begun about 1905. They were at first simply open pans, which gave off large quantities of black smoke and soot. Following the disastrous freeze in southern California in 1913, the "low-stack" oil heater came into more general use. The amount of smoke and soot was thus reduced somewhat, but combustion was still far from satisfactory.

Between 1915 and 1918 the so-called "high-stack" heater began to make its appearance. These heaters are more nearly smokeless than any other type that has been put on the market in commercial quantities. During a warm day, they will, with draft carefully regulated, burn with practically no smoke. But when hundreds or